the public, and they deserve the utmost condemnation. If physiologists can make out a case for themselves, I for one am prepared to give it the utmost attention, but they must not bring to their aid false illustrations from a branch of science with which I think I may be permitted to say I have had a large experience. LAWSON TAIT

Birmingham, October 6

IT seems sufficient for me to observe, in reply to the above, that before writing my review of "Physiological Cruelty" I took the trouble to acquaint myself thoroughly with the latest edition of Mr. Tait's pamphlet. GEORGE J. ROMANES

Breeding of "Hapale jacchus" in Captivity

MR. MOSELEY'S Marmosets (NATURE, vol. xxviii. p. 572) are by no means the first instance in Europe, or even in England. Edwards, more than a hundred years ago, recorded a case in Portugal; and Frederic Cuvier had three born in Paris in 1819 (*vide* Sir William Jardine's Natural Library—Mammalia, vol. i.). A relative of mine brought a pair of this species from Pernambuco in 1863, and kept them in his kitchen at Surbiton. In April, 1865, I was shown two living young ones which had been born a few days before. In the *Proc. Zool. Soc.* for 1835, births of marmosets of an allied species (*H. penicillatus*) have been chronicled as occurring in this country. W. C. ATKINSON

Streatham, S.W., October 13

TELESCOPIC WORK FOR THE AUTUMN

WITH Mars, Jupiter, and Saturn so favourably visible in the sky during the ensuing autumn and winter months, we think it may be interesting to call attention to some of their more prominent features, and to ask amateurs and others who devote themselves to the attractive field of planetary observation to make a combined effort, not only to substantiate such facts as are already known with regard to the physical appearances of these bodies, but to endeavour to glean something new concerning them. For, notwithstanding the diligence with which these planets have been scrutinised in past years and the many curious facts that have been brought to light, it must still be confessed that there remains much to be done. Our knowledge is admitted to be extremely incomplete. The powerful instruments of the present day do not seem capable of rendering us efficient aid in this respect; indeed we shall find by a comparison of results that we owe most of our discoveries to telescopes of moderate aperture. The real explanation probably is that, with increase of aperture, definition, especially of the brighter planets, becomes less perfect. Faint markings are obliterated or seen unsteadily and uncertainly in large instruments owing to glare, the difficulty of getting a sharp, hard disk with so much light, and the constant undulations of the atmosphere. With moderately small instruments the conditions are in many respects more favourable. The image is sharply defined, and though the quantity of light may be somewhat deficient, there is an absence of glare and of that atmospheric interference which are inseparable from large apertures. Moreover, the eye is more capable of prolonged observation and is enabled to glimpse the faintest details on an image of moderate intensity. The deficiency of light in small instruments is therefore to some extent a recommendation when it is accompanied with extreme sharpness of definition and when the amount collected by the object-glass or speculum is sufficient to allow a power to be used which displays a fairly large disk without destroying the quality of the definition. Indeed one great desiderative in such cases is to utilise light and power in agreeable proportion, for this is a very essential requirement, which is, however, often neglected, and is frequently the source of disappointing experiences. Amateurs who are careful to consider these matters will be enabled, though their instruments may be of comparatively small reach, to do much useful work in many departments of observation, and particularly in that relating to planetary markings.

With regard to Mars, high powers are very requisite because of the small diameter of the planet. Hence a fairly large aperture is necessary, for, unless the disk is considerably expanded, it is impossible to trace the chief features satisfactorily. In the case of Jupiter the use of high magnifying powers does not apply with so much force, the apparent diameter of the disk being greater. But this planet is a somewhat difficult object to define satisfactorily. The best telescopes will often fail to show the contour of the disk with desirable sharpness. Hence it is that this object with large apertures is troublesome and to some extent disappointing. This is certainly the case when we consider how efficiently and successfully small instruments perform upon this planet, and with what readiness the faintest and more minute of the details are distinguished. As to Saturn, the conditions are somewhat different. Here there is less light and the telescopic definition is better, so that large glasses possess an undoubted advantage.

The ensuing opposition of Mars is not a favourable one, but many of the most interesting and now well-known features of the planet may be observed in good instruments. The curious network of "canals," as discovered by Schiaparelli, and their duplication, as seen by the same observer during the last opposition, in the winter of 1881-82, should be looked for, as some doubts have been expressed as to the reality of these phenomena. The question is naturally asked, How is it that they are now seen with so much distinctness again and again with a refractor of only eight inches aperture, when large instruments have utterly failed to reveal them? Schiaparelli, it is true, works in a climate highly favourable to such delicate work, and his telescope, though comparatively small, is yet of the finest possible quality. But even with the prevailing conditions so eminentlyconducive to the attainment of such important results, it must still remain matter for surprise that, as the celebrated Italian astronomer himself put it, "the greater number of canals and of their pairs were observed with comparative ease whenever the air was still, and only a few cases required a special effort on the part of the observer."

These so-called canals appear from Schiaparelli's charts to be very narrow dark markings, running generally in straight lines, and often intersecting each other so as to constitute a perfect network about the equator and in the region south of it. Many of these lines were seen to be double in January and February, 1882, and the inference is that, as these duplications had escaped observation during the more favourable opposition of 1879, they are subject to periodical variations, or in any case represent phenomena of temporary character. They undoubtedly exhibit a most extraordinary arrangement, and such as naturally to call forth some amount of objectional comment from those who, though familiar with the telescopic aspect of the planet, have never seen it as Schiaparelli depicts it. In fact his delineations give a boldness and definiteness of outline in the smallest details which no other observer is able to corroborate. The extreme delicacy of shading and softness of outline so characteristic of many of the features of this planet as displayed in our best telescopes seem wholly wanting, and we have presented to us an elaborate complication of hard, dark lines which bear little analogy to our own impressions.

It has been suggested that many of these so-called "canals" are the edges of half-tone districts on the planet, and possibly this may be so in certain cases. But we must not forget that the eminent author of these important discoveries expresses himself very confidently as to their existence, for he has seen them repeatedly, and at times when the conditions were not favourable to the detection of such difficult markings. Probably something of them may be again observed during the ensuing winter, although the apparent diameter of the planet is very small and opposed to a critical investigation. Schiaparelli has, however, pointed out that "on January 1, 1884, the position of Mars with respect to its solstice will be identical with that which it had on February 13, 1882, and its apparent diameter will be 13″, that is to say, about equal to the apparent diameters which the planet had during the discovery of the parallel canals. Every telescope able to distinguish a dark line 0″·2 in breadth on a bright ground, and to separate the one from the other two such lines when the interval between axis and axis is 0″·5, could be employed for these observations and to study the duplications if these should be reproduced."

It is to be hoped that some of our best instruments will be devoted to this work during the ensuing winter, and that something of these curious features will be observed before the favourable opposition of 1892, when they will certainly be seen if ever. But there is the alternative that they are possibly variable and subject to periodical disappearances, though we can hardly consider this probable in view of the permanent character of the chief markings on the planet.

Jupiter has always been an object of great attention to the possessors of telescopes, not only on account of the readiness with which the satellites may be perceived, but also on account of the prominence and variety of his belt scenery and the marked changes which it undergoes from year to year. The well known red spot which appeared in the planet's southern hemisphere, and which first came prominently into notice in July, 1878, has proved a great stimulus to observation of late years. The large dimension of this spot, its intensely red colour, its definiteness of outline, and its durableness have combined to render it an object of extreme interest, and the phenomena of this planet, whenever it is described in future years, will never be complete without a reference to this marvellous feature. Persistently visible throughout a period exceeding five years, during which it has completed more than 4500 rotations, it would be imagined that it must afford an excellent means of fixing the rotation period of Jupiter with a degree of exactness far surpassing all previous efforts. But the spot has shown a retarded motion which constantly causes it to lag behind its predicted place. In other words, the rotation period has been lengthening. Mr. Marth found the average time to be 9h. 55m. 34·47s. from the observations between 1878–1881, but the spot now crosses the central meridian of Jupiter about two hours after its predicted times based on the period just referred to. In fact its time of rotation has lengthened fully three seconds during the past two years. But even had this spot been influenced by a perfectly accordant motion during the whole period that it has been watched, we could not regard its time as showing the true length of the Jovian day, for the disk of this planet exhibits a variety of spots which generally move much swifter than the red spot. On the equator the markings rotate in 9h. 50m. 7s. Both the dark and bright spots which alternate with each other on and near the equator, and are included in the two principal dark belts, participate in this rapid movement, and they show a fairly regular period, so that it is impossible to decide at present as to the true rotation of the planet's sphere. The brightest spot of all has been attentively followed since November, 1880, and it is found that relatively to the red spot it has, owing to its greater velocity, completed twenty-three revolutions of Jupiter. In other words, during 1026 days its swift proper motion has enabled it to sweep round, no less than twenty-three times, the vast circumference of the Jovian sphere! What phenomena can possibly have given rise to such a remarkable difference of motion in objects of fairly permanent character? The explanation is involved in mystery, and may never be forthcoming, but there can be no question as to the importance of following up these observations. The red spot now seems unfortunately to be in a state bordering on extinction. It has become so faint that it is only distinguished with care under circumstances of favourable definition.

Apart from the spots, which evidently offer a large field of very interesting work, there are the belts, which are constantly varying in colour, position, number, and intensity. At every opposition of the planet a series of sketches should be made of the aspect of the disk, for some important issue may result from the comparison of such drawings if existing over a long number of years. Some of the leading features may be found to recur at certain definite periods, for the drawings of the present day show many curious forms bearing a striking analogy to some observed at former times. In any case a reliable set of sketches for each opposition must give us an excellent basis for investigating the varying features of this planet, and may afford us a clue to some of the marvellous changes evidently progressing upon his surface. Telescopes of very moderate size can be usefully employed in these observations. I have seen sketches of Jupiter made with a 36-inch reflector, 18½-inch refractor, 18¼-inch reflector, and with many other instruments ranging from 12 to 18 inches. I have also examined a large number of similar sketches obtained with refractors of from 4¼ inches to 6 inches, and reflectors from 5¼ inches to 6½ inches, and carefully compared them together. The large instruments appear to have had no advantage whatever. Indeed, judging from the amount of detail presented in the sketches, and from the descriptions accompanying them, the small apertures would seem to have rather the best of the comparison!

One explanation may be that the detail rendered visible on Jupiter by large instruments is so extensive that it cannot adequately be delineated during the short interval available for sketching. The features change very rapidly, owing to the planet's swift axial rotation, and drawings made on different nights, when the longitudes are assumed to be coincident, are not reliable, because the different markings have become severally displaced owing to their differences of motion.

Saturn, though diversified with belts similarly to Jupiter, is less attractive as an object for telescopic study. The image of Saturn is beautiful as a picture, but there is a sameness about it which observation, renewed again and again, has a tendency to make monotonous. His belts are generally faint, and seldom show spots of decided character. During the last opposition the planet's southern equatorial belt was very dark and well defined, and exhibited differences in depth of shading, but these were not sufficiently distinct to be followed. On the equatorial margin of this belt the disk was very bright, and immediately contiguous to it are signs of white spots, which would suggest very similar phenomena to that discerned on Jupiter. Spots of sufficiently definite outline to be observed with certainty upon the globe of Saturn are extremely rare. Prof. Hall's white spot of 1877 affords one notable example of this kind, and doubtless the number of such observations would be greatly increased were more attention directed to this planet. Though sketches of Jupiter are frequent enough, we rarely see attempts to delineate Saturn, and thus we have comparatively few records as to the arrangement of his belts. This is to be regretted on many grounds. No doubt the rings of this planet monopolise observers to such a degree that they neglect other phenomena which, though less attractive, may be of greater significance and interest. Whenever such observations are practicable, particular attention should be given to the configuration of the belts, and a searching examination made for any definite markings which may be sufficiently obvious and permanent to be followed on successive nights, and thus enable a new determination of the rotation period. William Herschel found this to be 10h. 16m. 0·44s., and this has received excellent confirmation from Prof. Hall's observations in 1877, which indicated a period of 10h. 14m. 28·8s. Schrœter also glimpsed several spots indicating periods of about twelve hours, but these observations are probably erroneous, as they differ so widely from the corroborative results of Herschel and Hall. But it is possible that these distinctive markings on Saturn give anomalous periods similarly to the spots on Jupiter, though hardly to the extent of the differences between the existing observations. Were this planet more sedulously observed, it is certain that we should obtain some new and interesting facts with reference to his globe and rings. As to the belts, they are occasionally very plain; Grover has seen them with only 2 inches of aperture, and the writer distinguished them well in 1881 with a 2½-inch O.G. What, therefore, can be so readily seen in small telescopes ought to come out with considerable detail in the large instruments of the present day. As to the system of rings, it forms a complicated object for study. The marked differences in their tints and brightness should be recorded on all occasions. Cassini's division is always plain, but the outer and more minute division of Encke has sometimes defied the power of our best telescopes. It apparently varies both in position and intensity. Other faint subdivisions are sometimes traced, but they are very difficult objects, and seldom seen with certainty. The crape or gauze ring, together with other details, such as the anomalous shadow of the ball upon the rings, supply an endless store of curious appearances requiring further elucidation.

There is no doubt that, notwithstanding the mass of interesting facts gleaned in past years respecting the physical aspects of Mars, Jupiter, and Saturn, there remain many novel features to be distinguished, and many new facts to be descried. Observers, therefore, who make these observations a specialty should endeavour not only to confirm former results, but to make some advance upon our existing knowledge.

We have not space in the present paper to refer to the satellites of these several planets, but may possibly be able to do so on a future occasion. W. F. DENNING

THE INTERNATIONAL BUREAU OF WEIGHTS AND MEASURES[1]

II.

HAVING now given a description of the instruments used in the section of linear standards, we come to the apparatus belonging to the section of standards of weight.

As regards the essential instrument connected with the process of weighing, the International Bureau possesses one of the most remarkable collections of balances of precision existing in the world. Of these the principal ones have been constructed by the house of Rüprecht of Vienna. The large engraving accompanying this (Fig. 3) represents in its entirety the spacious chamber in which they are set up. In addition we gave a special sketch (p. 465, Fig. 2) of the balances principally designed for comparison of standard kilogrammes. This balance is constructed in such a manner as to adapt it for being worked at a distance, whereby it is kept free from the disturbing influence always occasioned in the process of weighing by the proximity of the observer, in consequence of the variations of temperature which his presence close to the balance gives rise to. In the case of the instrument now in question, the observer, having prepared his weighing apparatus the preceding day,—that is, placed the weights he will have occasion to use in their right positions in the pans of the balance,—avoids any longer going near the balance. Standing in front of his telescope he performs all the operations involved in weighing that is, he puts the weights on the pans, releases the pans, and then the beam, and measures the oscillations of the beam; then changes the weights from one side to the other, placing that to the right which was at the left, and conversely, &c., the whole at a distance of four metres. For that purpose the balance is provided with a mechanism very ingenious and of perfect precision which works automatically by means of handles fixed to the extremity of long rods. The oscillations of the beam are read by the reflection of a graduated scale on a mirror borne by the beam; it is the image of that scale the observer sees displacing itself slowly in his telescope while the balance oscillates. He notes a certain number of successive oscillations, and thence calculates the position of equilibrium.

Three other balances, of the same model but smaller, are intended for comparisons and adjustments of lighter weights. They have the same mechanism of transposition, only in the case of the two smallest, a little more simplified and less complete. In the centre of the large engraving (Fig. 3) are seen the large arms of the lever which allow the weighings to be made at a distance. These arms rest on three stone pillars, above which are placed the telescopes for reading the oscillations of the beam.

The following are some details of the mechanism of transposition employed in this balance. The pans of the balance have a shape altogether peculiar. Each is formed by a circular piece open at one point and extending itself inwards by four triangular plates or teeth directed towards the centre of the balance. A cross piece placed underneath can be passed between these plates. Suppose now that weights, say of one kilogramme each, are placed above the pans on each side; and to make the idea the more definite let the kilogramme A be on the left scale and the kilogramme B on the right. Taking hold of one of the four handles under his hand, the observer sets the mechanism in motion. This is what happens:—the cross piece placed under the pan mounts at first, ascends beyond the plane of the pan and consequently lifts the kilogramme resting above it. Arrived at a suitable height the cross piece shifts its place laterally, and disengaging itself from the pan it gradually gets deposited above one of the plates, attached right and left to the pillar of the balance. These plates follow an arrangement analogous to that of the pans. By continuing the movement the cross piece then commences to descend, and traverses the plane of the plate, depositing on it the kilogramme which it has raised from the scale. While these movements are effected to the left in the case of the kilogramme A, they are in simultaneous accomplishment to the right in the case of the kilogramme B. The two weights to be compared are thus transferred at the same time to the central plates. Then taking hold of a second handle the observer turns the two plates 180° round the axis of the pillar of the balance, a movement which shifts the plate which was at the left to the right, and conversely. All that is needed then is to cause the same evolution to be gone over again with the crosses which they have already done, but inversely, in order to bring back the kilogrammes to the scales of the balance; the kilogramme A is then at the right, the kilogramme B at the left, and the observer can proceed to the second part of the weighing.

The two other handles control—one the movement serving to release the pans, the other the movement lowering the fork and setting free the beam.

For a long time it has been known that the balance is an instrument of precision *par excellence*. By means of those here in question the minimum amount of error in the process of weighing has been reduced to an almost infinitesimal degree. The difference of two kilogrammes, for example, can by them be determined to a nicety reaching to the hundredth of a milligramme, that is, the weight of a kilogramme is ascertained down to within a hundred millionth of its absolute value.

In another part of the hall is shown the hydrostatic

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[1] Continued from p. 466.